Technical Report 758

The Development and Evaluation of Moving Target Engagement Training Programs With the M16A1 Rifle

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Moving target engagement training is conducted on the Fort Benning Defense Test Range (DTR), which is equipped with the Remoted Target System (RETS) and uses a stationary and moving target attack/retreat scenario. In June 1985 a research effort was initiated to examine current Advanced Rifle Marksmanship (ARM) training at the DTR and to conduct research on alternative methods of training moving target engagement. Several variations of training devices and procedures were developed and evaluated. Strategy (Continued)

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20. Abstract (Continued)

incorporating existing resources, as well as a special training devices strategy, were developed and tested. Findings indicated that both training strategies significantly increased moving targets hit by low-ability shooters from pretest to posttest. In addition, both strategies resulted in more posttest moving target hits than the current training program. Keywords:

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Education and Training

FOREWORD

There have been 23 published research products relating to rifle marksmanship since 1978. The majority of published research has focused on the Basic Rifle Marksmanship (BRM) program and skills for the engagement of stationary targets. This research has been critical in the evaluation of training effectiveness related to rifle skills essential to the soldier. The results of these research efforts have improved overall performance of soldiers by approximately 30% in the engagement of stationary targets.

The battlefield has a multitude of personnel targets, both stationary and moving. Shooting moving personnel targets represents an equally important skill for the soldier. The research effort described in this report was monitored by the Army Research Institute's Fort Benning Field Unit, whose mission is to conduct research and development of training and training technology using Infantry combat systems and problems as the vehicles. the major focus is on the field experimentation within the Infantry arena with the goal of obtaining results that can be generalized to similar systems/problems in other segments of the Army or other services. Primary emphasis is on training systems/training technology, team training, and weapons systems training, all to improve the performance of soldiers and units. The research task that supports this mission is titled "Developing Training for Individual and Crew-Served Weapons," which is organized under the "Train the Force" program area. Providing sponsorship for the research effort was the United States Army Infantry School (USAIS) under letters of agreement "Joint Efforts on Improved Training for Moving Target Engagement and Other Advanced Marksmanship Skills," dated 20 December 1984. The work described in this report was presented to the USAIS in December 1986. It is expected that the findings will be used to revise current training methods. Recommended revisions to training are expected to be implemented in the next Advanced Rifle Marksmanship (ARM) Program of Instruction (POI).

EDGAR M. JOHNSON
Technical Director

THE DEVELOPMENT AND EVALUATION OF MOVING TARGET ENGAGEMENT TRAINING PROGRAMS WITH THE M16A1 RIFLE

EXECUTIVE SUMMARY

Requirement:

To develop a training program that will significantly improve the soldier's ability to hit moving personnel targets.

Procedure:

Program efforts using existing resources involved revising current training methods to improve performance on engaging moving targets. In addition, training methodology was developed for four special training devices: Aid to Improved Marksmanship (AIM) book, the Multipurpose Arcade Combat Simulator (MACS), the Weaponeer II, and a Location of Miss and Hit (LOMAH) electronic projectile location system.

Infantry One Station Unit Training (OSUT) soldiers were randomly selected from multiple companies to serve as test personnel and were assigned to either control or experimental groups. Equal distribution of marksmanship skills between control and experimental groups was determined by Basic Rifle Marksmanship (BRM) qualification scores. Control groups received the current moving target engagement period of instruction in the Advanced Rifle Marksmanship (ARM) Program of Instruction (POI). Experimental groups received either revised training procedures with existing training resources or revised training procedures with special training devices. All live firing was conducted on a Defense Test Range (DTR) equipped with the Remoted Target System (RETS). Pretest and posttest measures of performance were based on a live-fire scenario of 42 targets, 28 of which were moving.

Findings:

Soldiers in the experimental groups, on average, had four additional hits from pretest to posttest results. However, the use of group means as a measure of performance was found to mask the substantial improvement exhibited by the low-ability pretest shooters in the experimental groups. The posttest performance of low-ability soldiers was 104% greater than their pretest performance in terms of the total number of targets hit. In comparison the control groups showed a 67% improvement from pretest to posttest in total targets hit.

Utilization of Findings:

An increased number of moving targets hit should be expected if recommended revisions to current training methods are implemented. The U.S. Army

Infantry School (USAIS) has been briefed on the findings of this research and it is expected that the recommended revisions will be implemented within the ARM POI. In addition, it is expected that the research findings will be used by Army decision makers in their determination of the future training priority of this important combat skill. Utilizing special devices could increase moving targets hit without an increase in ammunition from current requirements, especially if used as a diagnostic tool in identifying skill deficiencies of low-ability shooters.

THE DEVELOPMENT AND EVALUATION OF MOVING TARGET ENGAGEMENT TRAINING PROGRAMS WITH THE M16A1 RIFLE

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THE DEVELOPMENT AND EVALUATION OF MOVING TARGET ENGAGEMENT TRAINING PROGRAMS WITH THE M16A1 RIFLE

INTRODUCTION

The ability to hit moving personnel targets with the M16 rifle represents one of the most difficult tasks for the Infantry soldier. This difficulty is compounded by the multitude of moving targets on the battlefield. The combination of these factors requires the soldier to proficiently detect, react, and successfully engage a target as quickly as possible. At present, the Army lacks an effective, low-cost means for training soldiers to engage moving personnel targets with a rifle.

In 1975, the need for a new target system with which to conduct Army rifle marksmanship training was formally documented (US Army Infantry Board, 1983). Existing range configurations did not adequately represent the dismounted enemy threat to the rifleman and lacked moving personnel targets. As a result of that need, an Infantry Remoted Target System (IRETS) was developed and installed on the Defense Test Range (DTR) at Fort Benning, Georgia in the Fall of 1978.

Previous research on moving target engagement training identified two major problems: (1) soldiers lacked the skills and knowledge necessary to engage moving targets effectively and (2) the Army lacked the means and methods necessary to train soldiers to engage moving targets (Schendel & Heller, 1981). As a result of this research, two training aids for moving target engagement were developed: the Aid to Improved Marksmanship (AIM) book and the Dry Fire Moving Target Trainer (Dry Mover). AIM is an inexpensive, self-paced, performance-based training supplement designed to provide a basic understanding of the M16 rifle sight picture and the effects of gravity and target motion on the point of aim. The Dry Mover was designed to provide inexpensive dry fire training in engaging moving targets on and off the range.

In 1982 an evaluation of the Advanced Rifle Marksmanship (ARM) Program of Instruction (POI) used for Infantry One Station Unit Training (OSUT) was conducted. It was found to have three major problems: (1) limited scope of training; (2) inappropriate automatic fire and night fire training; and (3) inadequate feedback on bullet location (Evans and Schendel, 1984). As a result of this research, automatic fire training was reduced, night fire training was revised, and three new instructional periods were developed for quick fire, rapid semiautomatic and suppressive fire, and moving target engagement. The AIM book and Dry Mover were utilized in the 8 hours devoted to engaging moving personnel targets. Although formal evaluation of this revised 24-hour program was not conducted, it was fully implemented in May 1982 at Fort Benning, Georgia.

An additional research effort focused on two methods of engaging moving targets: tracking and trapping (Schendel & Johnston, 1983). Tracking involves maintaining the muzzle of the weapon at a selected aiming point leading the target in the direction of travel and firing when the target is properly aligned with the sights. Trapping involves holding the muzzle slightly ahead of the target in its expected direction of travel and firing when it passes through the

aiming point. All testing was conducted using the Weaponeer II, a prototype moving target training device manufactured by Spartanics Ltd., Rolling Meadows, IL. Based on the results of this research, the authors suggested that a flexible approach to moving target training should be adopted. It was found that low ability subjects performed better trapping targets and high ability subjects performed better tracking targets. An additional finding indicated that trapping was a superior method of engaging moving targets at the greatest distance (250 m) moving at the slowest speed (1 m/s), and tracking was superior for engaging close-in targets (50 m) moving at the fastest speed (3 m/s).

During the period 14 May through 28 July, 1983, the US Army Infantry Board conducted Operational Test II (OT II) of the IRETS at Fort Benning, Georgia (US Army Infantry Board, 1983). The test focused on the use of IRETS to conduct rifle marksmanship training and on the reliability, maintainability, human factors, and safety characteristics of IRETS. As a result of OT II, equipment changes were introduced in an attempt to improve the performance of IRETS. However, rifle marksmanship data collected during this research effort showed no performance differential for moving targets hit between soldiers receiving moving target training and soldiers receiving only stationary target training.

Upon completion of the IRETS Operational Test II in 1983, a new 50-target/80-round scenario was developed by Army trainers for use during the moving target engagement period of the ARM POI. An analysis of data from 4,176 soldiers who most recently fired the 50-target/80-round scenario indicated that the mean number of total hits was 16. The mean hit probability for moving targets was .37 and the mean hit probability for stationary targets was .25. A summary of hit probability by range is shown in Table 1.

Observation of current instruction revealed a number of problems that appeared to detract from the marksmanship performance of soldiers. Many soldiers were unable to perform a rapid magazine change efficiently and to apply immediate action to clear a rifle malfunction. This contributed to their loss of target engagement opportunities. The sequencing of concurrent training stations did not provide a logical progression in training from understanding the principles of engaging a moving target, to dry-fire practice, to tracking a live target. Superfluous information was presented during concurrent training on lead rules, firing positions, and targets that were not pertinent to the live-fire training at the DTR. Training prior to live-fire emphasized moving target engagement only. Stationary target engagement was not even mentioned. The low hit probability for stationary targets (see Table 1) appeared to be due to the failure of many soldiers to detect these targets.

The main purpose of the current research effort was to improve the ability of soldiers to engage moving targets. This research effort involved development and evaluation of two separate types of experimental training programs, one utilizing existing training aids and range facilities, and the other using special training devices and existing range facilities. Existing training programs were modified by changes in training methodology, the use of special devices, and the development of new scenarios. In addition, several peripheral issues were investigated: the effects of different modes of fire, the effects of additional ammunition on the number of targets hit, and the effects of different methods of target engagement on the number of targets hit. A series

of eight experiments, in which 537 soldiers were tested, was conducted in the period from July 15 to September 13, 1985. The rationale underlying the experiments conducted in this overall effort was to provide an instructional setting using new training methods that were conducive to learning.

Table 1

Hit Probability by Range for the 50-target/80-round Scenario

Range (m)	Stationary Targets (pH)	Range (m)	Moving Targets (pH)
300	666/7531 = .09	185	557/2815 = .20
250	1291/7828 = .17	125	8858/44294 = .20
200	4519/24475 = .19	75	7667/20805 = .37
150	3352/7792 = .43	35	13559/27307 = .50
100	3030/16632 = .18	15	9944/15911 = .63
50	9783/24932 = .39		
Total	22641/89190 = .25	Total	40585/111132 = .37

Total Hits/Total Exposures (pH) = 63226/200322 = .32

EXPERIMENT 1: EVALUATION OF A ONE-DAY TRAINING PROGRAM

The purpose of this experiment was to determine the effectiveness of a revised moving target engagement training program that would take no more time to conduct than the current period of instruction. Presently, no more than 8 hours is devoted to the task of moving target engagement.

Method

Subjects

Subjects were 84 Infantry OSUT soldiers undergoing ARM training at Fort Benning, Georgia. Soldiers were assigned either to a control group (n = 42) or an experimental group (n = 42). Soldiers were randomly selected from companies scheduled for moving target engagement training at the Defense Test Range (DTR), with the exception that the control group and the experimental group consisted of the same number of experts, sharpshooters, and marksmen as determined by their BRM qualification scores.

Equipment and Measures

Defense Test Range (DTR). Subjects in the control and experimental groups utilized the DTR for live-fire training and testing. At the time this testing was conducted, the range, equipped with the Remoted Target System (RETS), consisted of seven individual lanes, each with a foxhole firing position. There were 11 stationary targets at ranges from 25 m to 300 m and six moving targets at ranges from 15 m to 185 m. The rate of movement for moving targets can be manually set at each target carrier on one of three speed settings. Target selection, sequence and exposure times are computer-controlled, which allows for single or multiple target exposures to be programmed in a variety of scenarios. Moving targets are three-dimensional E-type silhouettes, positioned on a 10 m track at an approximate angle of 45 degrees to the firing line, whereas stationary targets are two-dimensional F-type (prone) silhouettes to ranges of 100 m and E-type (kneeling) silhouettes at ranges beyond 100 m. All stationary targets are perpendicular to the firing line. Target hits are automatically recorded and printed for each lane with the number of hits at each target range and the total number of targets hit.

The control and experimental groups fired a 42-target/42-round simulated attack/retreat scenario as a pretest and as a posttest. The 42-target/42-round scenario was fired by each soldier from an individual foxhole position. Computer-controlled targets appeared at distances between 15 m and 300 m. This scenario included six stationary targets at ranges from 50 m to 300 m and six moving targets at ranges from 15 m to 185 m. Soldiers were required to engage 42 targets (14 stationary, 28 moving) with 42 rounds of ammunition. The targets appeared without warning at intermittent intervals throughout the scenario. Both single and multiple exposures of targets were presented. Moving targets traversed both left and right at apparent lateral speeds of 2.8, 4.8, and 5.7 mph depending on their distance from the firing position (see Footnote 1). The

15 m and 35 m moving targets moved at the fastest speed (5.7 mph), the 75 m and 125 m moving targets moved at the intermediate speed (4.8 mph), and the 185 m moving target moved at the slowest speed (2.8 mph). After the command from the control tower to "watch your lane" was given, target engagement commenced when the first target appeared and continued without interruption for 234 s. Average time between target exposures was 1.3 s. The scenario required the soldier to execute a rapid magazine change and to correct any rifle malfunctions. At the completion of the scenario, a summary sheet of the hits at each target range and the total number of hits was printed for each firing position.

Data obtained from the summary sheets were used to evaluate the performance of the control and experimental groups on the pretest and the posttest. The measures used for these analyses were the number of stationary targets hit, the number of moving targets hit, and the total number of hits for each soldier in each group.

Aid to Improved Marksmanship (AIM). The AIM book pictorially represents a series of scaled walking or running targets at ranges of 75 m, 125 m, and 185 m. The left half of a transparent overlay, where the correct sight alignment of the front and rear sights of a rifle are superimposed, is placed over each target by the soldier according to the amount of lead distance considered appropriate. A dot on the right half of the overlay depicts where a bullet should impact, given the amount of lead selected. This book was developed by the Army Research Institute Field Unit at Fort Benning, Georgia (see Evans & Schendel, 1984 for a more detailed description). When using this training aid, soldiers in the experimental group were instructed to use only the single lead rule (Figure 1), while those in the control group were permitted to use as many as five lead rules based upon range and speed of the target.

Dry Fire Moving Target Trainer. The Dry Fire Moving Target Trainer (Dry Mover) is a mechanical training aid that was used for moving target preparatory marksmanship training of soldiers in the control group. This training aid is driven by a variable speed electric motor that allows both clockwise and counterclockwise movement of a scaled 75 m target located on both ends of a rotating arm (Figure 2). Soldiers form a circle around the Dry Mover five meters from the target and simulate engaging the target with their rifles during each rotation. The Dry Mover was developed by the Army Research Institute at Fort Benning and was built by the Training and Audiovisual Support Center (TASC) at Fort Benning, Georgia (see Evans & Schendel, 1984 for a more detailed description).

Superdart Location of Miss and Hit (LOMAH) System. The Superdart LOMAH system is a live-fire supersonic projectile location system distributed by Australasian Training Aids, USA, Inc., of Columbia, South Carolina. It includes a detector bar, located beneath an E-type silhouette target, which senses the sonic energy generated from a supersonic projectile passing overhead. Readings from the sensors are used to calculate the exact location of the passing projectile. This system is capable of distinguishing between a target hit, a target miss, a ricochet hit, and a ricochet miss (Smith & Osborne, 1985). The location information for each shot is presented in relation to the target on two video monitors, one located adjacent to the soldier at the firing point and the other located at a control point behind the firer. The target mechanism is

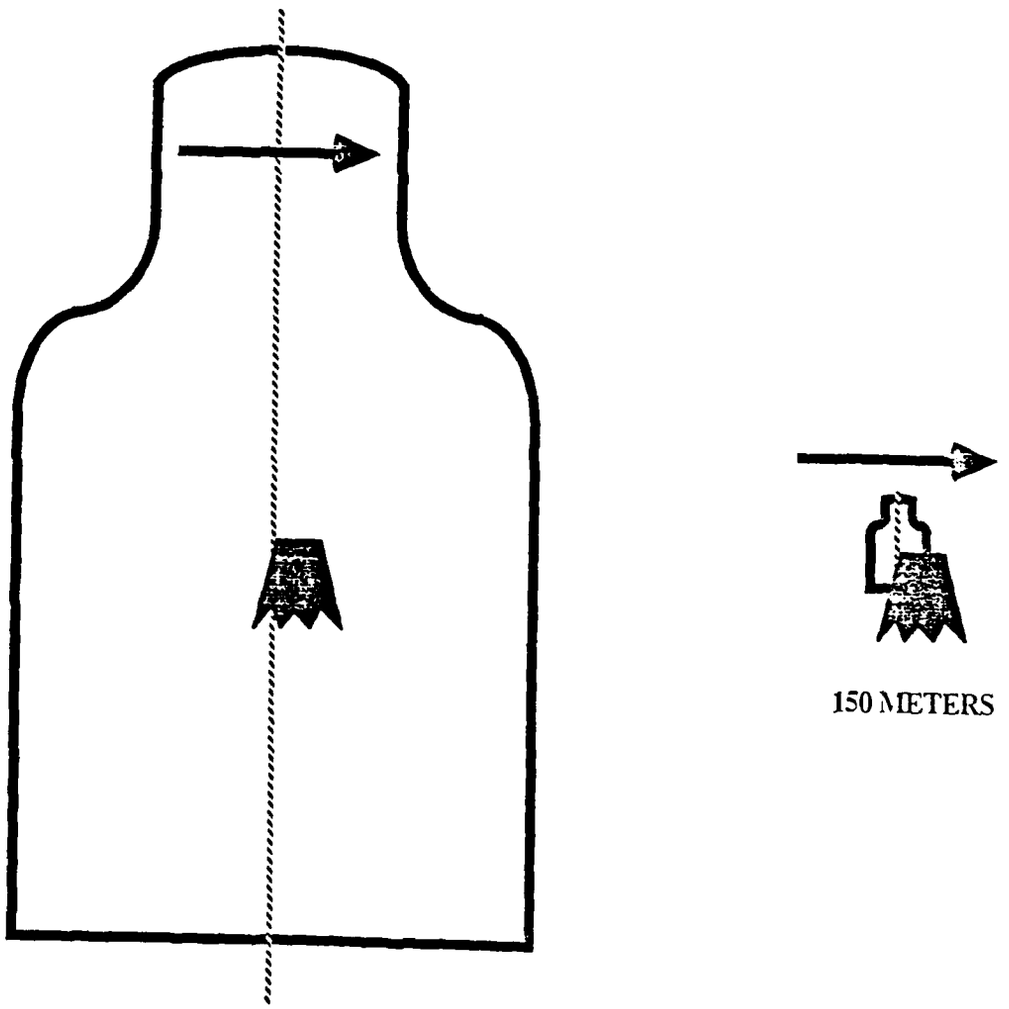

Figure 1. Single lead rule for engaging moving targets.

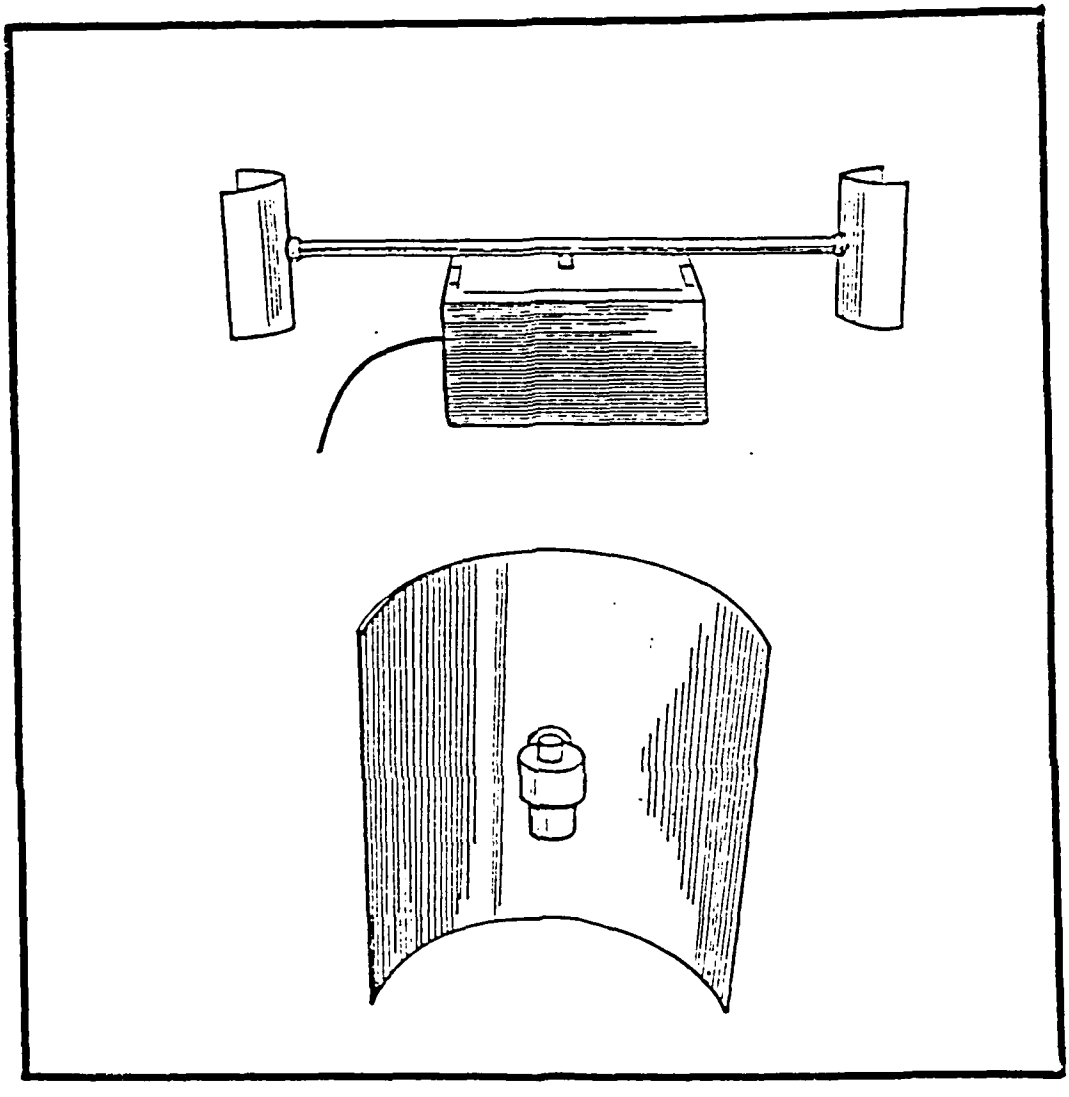

Figure 2. Dry fire moving target trainer (dry mover).

remotely controlled by an operator at the control point. Three target speeds can be set by adjusting three rheostats located downrange near the target. The system is supported by a Hewlett Packard 9915 microcomputer. It is illustrated in Figure 3.

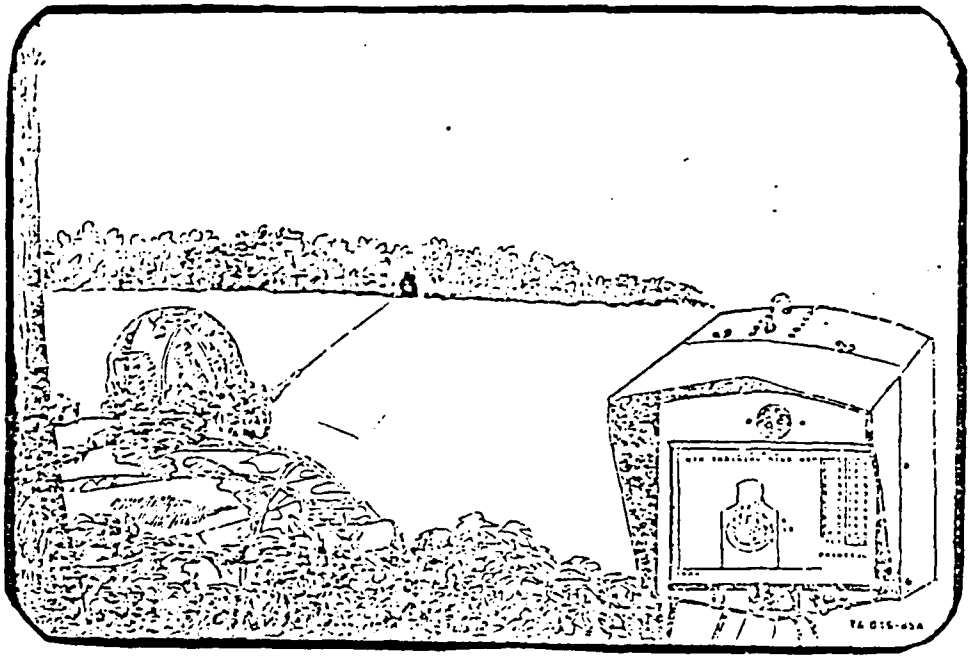

Figure 3. Location of miss and hit (LOMAH).

Weaponeer II. The Weaponeer II is a prototype marksmanship training device manufactured by Spartanics Ltd., Rolling Meadows, Illinois (Figure 4). This system allows semiautomatic and automatic fire training in all firing positions at stationary and moving targets. This device provides the instructor with a video display showing the target, the exact position where the rifle is aimed, and the point of bullet impact. It has 14 training programs each comprised of three levels of difficulty. After completion of each program, the instructor can obtain a hardcopy of performance data for each soldier from a built-in printer. A detailed description of this device, with the exception of software modifications in the current prototype, was given in Schendel and Johnston (1983).

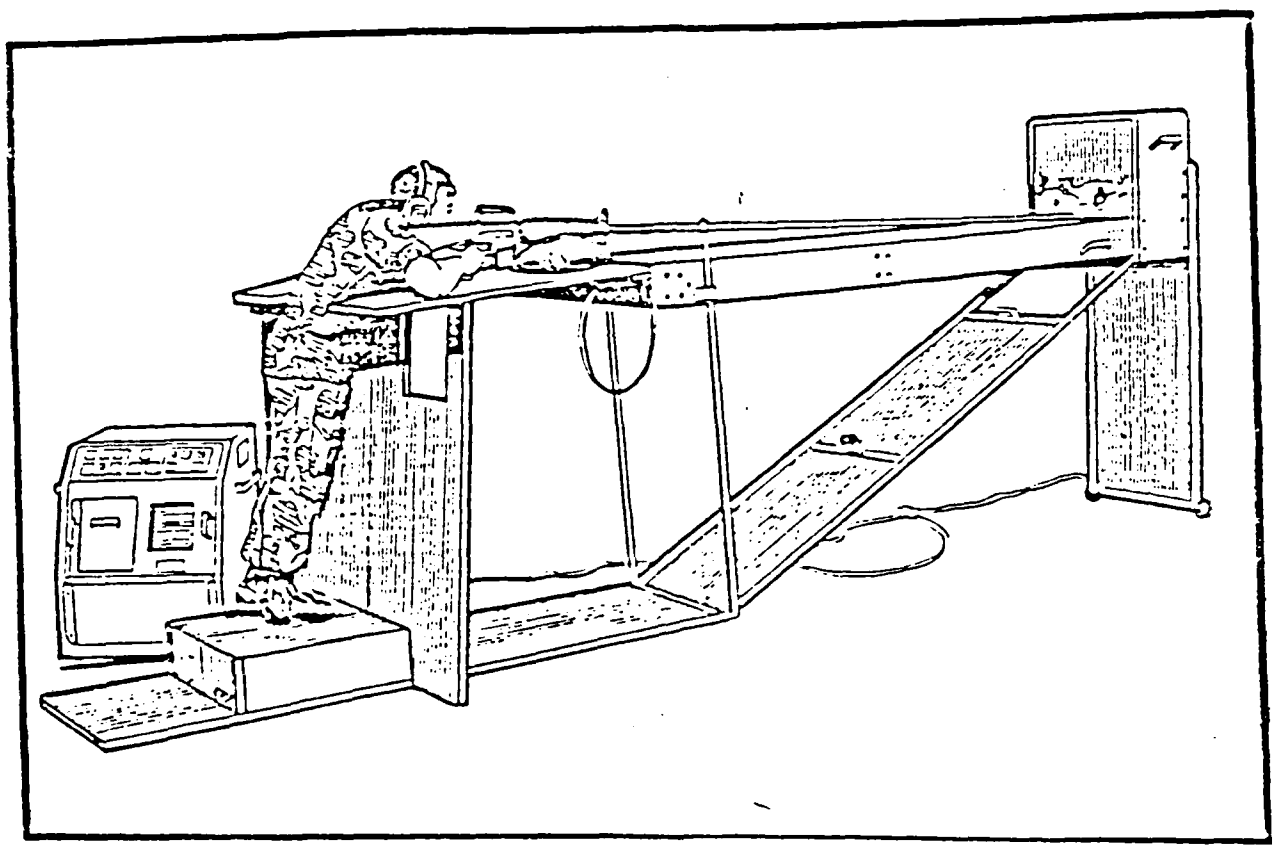

Figure 4. Weaponeer II.

The Multipurpose Arcade Combat Simulator (MACS). The MACS system is an inexpensive part-task trainer/simulator being developed at the Army Research Institute Field Unit at Fort Benning. The system consists of a Commodore 64K microcomputer, a Commodore disk drive (Model No. 1541), a color monitor and a dummy M16A1 rifle with a SYMTEC long-range light pen attached to the barrel (Figure 5). A more detailed description of this system can be found in Hunt, Broom, Greene, Crawford, Martere, and Parish (1986). MACS was designed so that the same general hardware can be used to provide dry-fire training on different weapon systems by simply moving the light pen from one weapon to another and changing the software.

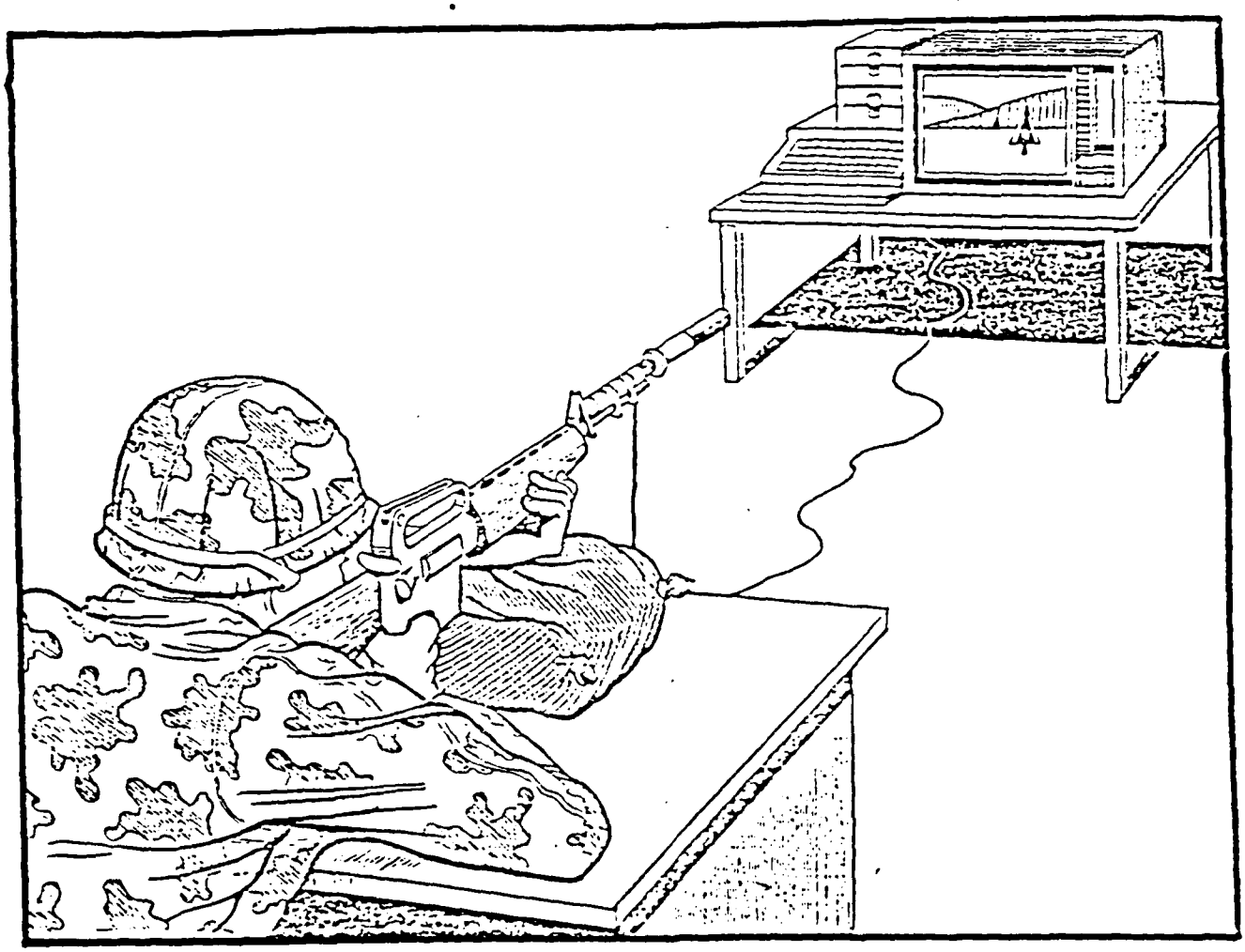

Figure 5. Multipurpose arcade combat simulator (MACS).

Procedure

The control and experimental groups fired a 42-target/42-round attack/retreat scenario on the DTR as a pretest. After the pretest, soldiers in the control group (n = 42) remained with their company and received the current ARM POI for engaging moving targets. Initially, a safety briefing and live-fire demonstration were presented. The company was then divided into three groups and rotated through three stations of training. The three stations consisted of training with the AIM book, the Dry Fire Moving Target Trainer, and a live target tracking exercise. The AIM book was used to instruct five lead rules for the engagement of moving targets. The Dry Fire Moving Target Trainer (Figure 2) was used to teach soldiers to lead and track a moving target. It was also used to practice rapid magazine changes. The target tracking exercise involved tracking a live moving target at a distance of 10 m while in a supported foxhole position. Each station of training lasted 35 to 40 minutes.

The experimental group (n = 42) received modified training that included the AIM book and device training on the MACS, Weaponeer II, and LOMAH systems (see Footnote 2). The AIM book instruction was modified to teach soldiers a single lead rule of moving target engagement (Evans & Schendel, 1984; Osborne & Smith, 1984). The single lead rule was proposed as an alternate and simpler method of engaging most moving targets out to 200 m. The single lead rule requires placing the trailing edge of the front sight post at target center in the direction of target travel (see Figure 1).

After completion of the pretest and the AIM book instruction, the experi mental group received training with two programs on the MACS system: a modified record fire program and a moving target program. At the start of each program, the soldier was required to fire a five-round shot group at a scaled 250 m target. This shot group was electronically zeroed by the MACS system. The modified record fire program was comprised of a 40-target scenario with target exposures two-thirds of the duration of target exposure times in a standard record fire scenario (Department of the Army, 1983). This program was used to provide training in target detection and the rapid engagement of targets. The moving target program was comprised of three target exposures at each of three target ranges (75 m, 125 m, and 185 m). The speed of the scenario targets was based on the reported speed of targets on the DTR (see Footnote 1). The actual speeds of the scenario targets were converted to apparent lateral speed because the RETS targets at the DTR move at an angle of 45 degrees to the firing line. The apparent lateral speeds were 2.8, 4.8, and 5.7 mph respectively. Immediately after firing each shot, three different types of visual performance feedback were presented to the soldier on the MACS monitor. First, crosshairs were superimposed on the screen to indicate the precise location of the shot. Second, the soldier's performance was numerically summarized by the microcomputer using five diagnostic measures: lead, tracking/trapping, trigger squeeze, follow through, and shot location. Third, a replay of each target engagement was presented showing the movement of the firer's front sight in relation to the moving target and in relation to perfect execution of the single lead rule (see Hunt et al., (in preparation) for a more detailed description of this program).

A progression of three programs was used for the Weaponeer II instruction: a zero program, a predictable target location program, and a record fire program. The zero program allowed each soldier to obtain his own zero on the device. The soldier fired a three-round shot group at a scaled 250 m stationary E-type silhouette without looking at the visual display monitor. If the shot group (depicted on the video display) was within a 16 grid square area (a 4 x 4 matrix), equivalent to an 18 inch group at 250 m, the instructor was able to electronically zero the weapon with the machine's console. If a soldier was unable to zero, the program could be repeated until a zero was obtained. Once a zero was obtained, the soldier was required to confirm zero by firing a second three-round shot group.

The Weaponeer II predictable target location program was comprised of a tracking exercise in which soldiers were required to track and engage a moving target at three ranges (50, 100, and 150 m). Successful engagement of a target was denoted by a high-pitched auditory tone, and a target miss was denoted by a low-pitched auditory tone. Soldiers engaged a stationary, walking, jogging, and running target at each range. The successful engagement of all targets at one range allowed the program to progress to the next target range. If a target was missed the program automatically paused. This allowed the instructor to give augmented feedback to the soldier explaining why he missed the target. In addition, the soldier received visual feedback indicating shot locations on the video display. A total of 24 target exposures, moving both left and right at each range, was used in this program. Upon completion of the scenario a printout of each target at each range was obtained indicating shot location, total number of target exposures, and the time required to complete the scenario.

The Weaponeer II record fire scenario was comprised of 40 (10 stationary, 30 moving) scaled targets at ranges from 50 to 250 m presented in a random sequence with varying target speeds, directions of movement (i.e. left and right), and exposure times. No feedback was given during the scenario. Upon completion of the scenario a summary of each target at each range indicating shot location, number of targets hit, and number of target misses was obtained on a printout. This information was used by the instructor to give augmented feedback to the soldier.

The Superdart LOMAH system was used to apply the single lead rule taught during MACS and Weaponeer II training to a live-fire situation. Soldiers fired 20 rounds at an E-type silhouette located 100 m directly in front of the foxhole. Five rounds were fired at a stationary target to confirm zero. This was followed by 15 presentations of the target moving either to the left or right at a rate of 2.8, 4.8 or 5.2 mph. Immediate visual feedback of each shot's location in relation to the target was presented to the soldier on the VDU located at the firing position after each round was fired. The hits, misses, and X and Y coordinates of each shot fired were obtained on a printout at the conclusion of the scenario.

On completion of device training, the experimental group rejoined their company during the firing of the 42-target/42-round scenario at the DTR. The second firing of the 42-target/42-round scenario for soldiers in the control and experimental groups served as the posttest for this experiment. Soldiers in

both groups were assigned to a specific firing point during the pretest; each soldier fired the posttest from the same assigned firing point. Pretest and posttest data for the control and experimental groups, as well as performance scores for the remainder of the company, were collected from the computer located in the range control tower for later analysis.

Results

A 2 (Group) x 2 (Stationary Targets, Moving Targets) x 2 (Pretest, Posttest) analysis of variance (ANOVA) with repeated measures on the second and third factors was used for this experiment. A Bartlett's test for homogeneity of variance indicated that the control and experimental groups were of comparable ability prior to moving target engagement training, $X2(1, N = 84) = .59$, $p > .05$.

The primary concern of this experiment was to determine the effectiveness of the revised moving target engagement program compared with the current scheduled training. The Group x Target x Pretest/Posttest interaction was not significant, $F(1,82) = 1.84$, $p > .05$. This finding indicated that performance for the treatment groups did not differ for stationary or moving targets, although the means for the experimental group were consistently in the expected direction.

A summary of the performance of soldiers in the experimental and control groups on the pretest and posttest is presented in Table 2. Note that standard deviations were consistently lower on the posttest than on the pretest, indicating that the performance of soldiers varied more prior to training than after training.

An additional analysis was conducted in this experiment based on soldiers' initial marksmanship ability. Soldiers were assigned to one of four groups based on individual pretest total scores on the DTR: (1) low ability control ($n = 10$); (2) high ability control ($n = 10$); (3) low ability experimental ($n = 10$); and (4) high ability experimental ($n = 10$). A 2 (Group) x 2 (Initial Ability) x 2 (Stationary Targets, Moving Targets) x 2 (Pretest, Posttest) ANOVA with repeated measures on the third and fourth factors was used in this analysis.

The Group x Ability x Target x Pretest/Posttest interaction, $F(1,36) = .004$, $p > .05$, was not significant. However, the Ability x Target x Pretest/Posttest interaction was marginally significant, $F(1,36) = 3.91$, $p < .06$. This interaction is illustrated in Figure 6.

Discussion

The pretest to posttest comparisons indicated no significant increase in any of the performance measures for the control group. This suggested that there was minimal learning associated with current moving target engagement training. Similarly, the results obtained for the experimental group were not significant even though the trend of the means was in the expected direction.

The between-groups results obtained indicated that the use of device-based instruction in conjunction with live-fire during a one-day training program was largely ineffective. However, the findings for this experiment were based on group means and in some cases these data are non-representative of individual improvements between pretest and posttest scores.

The most significant finding in the analysis based on initial ability was the differential benefit of the same training program. These data indicated that device-based training was extremely beneficial to the low ability soldiers and made no significant difference to soldiers in the high ability group. In addition, the beneficial effects of device-based training for low ability shooters was achieved by minimal soldier/device contact. The next experiment was designed to eliminate the potential problem of information overload by spreading training over two days in which the pretest and training on MACS and Weaponeer II were given on Day One and training on LOMAH and the posttest were given on Day Two.

EXPERIMENT 2: EVALUATION OF A TWO-DAY TRAINING PROGRAM

There are several explanations which may account for the statistically non significant comparisons between the control and experimental groups in Experiment 1. An observation by the research staff was that soldiers in the experimental group were required to absorb a large amount of information in a short period of time. This intensive training may have resulted in performer fatigue and an associated detriment in posttest performance (Schmidt, 1982). Thus, learning during the one-day training program may have been limited by an information overload associated with an intensive training program. The purpose of this experiment was to determine the effectiveness of the revised moving target engagement program outlined in Experiment 1 during a two-day training program.

Method

Subjects

Subjects were 56 Infantry OSUT soldiers undergoing ARM training at Fort Benning, Georgia. Soldiers were assigned either to a control group (n = 28) or an experimental group (n = 28) (see Footnote 3). The same procedure for selecting and grouping subjects was used as described for the one-day training program.

Equipment and Measures

The same equipment and measures were used as for the one-day training program.

Procedure

The control and experimental groups fired a 42-target/42-round attack/retreat scenario on the DTR as a pretest. After the pretest, the control group (n = 28) rejoined their company (see Footnote 3). The experimental group (n = 28) received modified training that included the AIM book and device

Table 2

A Summary of the Number of Hits Obtained by Each Group in the One-Day Training Program

Type of Target		Group: Experimental (n = 42)	Group: Control (n = 42)
Moving			
pretest	M	11.80	11.59
	SD	4.06	4.11
posttest	M	13.29	12.74
	SD	3.39	3.41
Stationary			
pretest	M	5.50	6.21
	SD	2.59	2.97
posttest	M	6.67	5.64
	SD	2.32	2.22
Total			
pretest	M	17.30	17.80
	SD	5.73	5.86
posttest	M	19.95	18.29
	SD	4.55	4.72

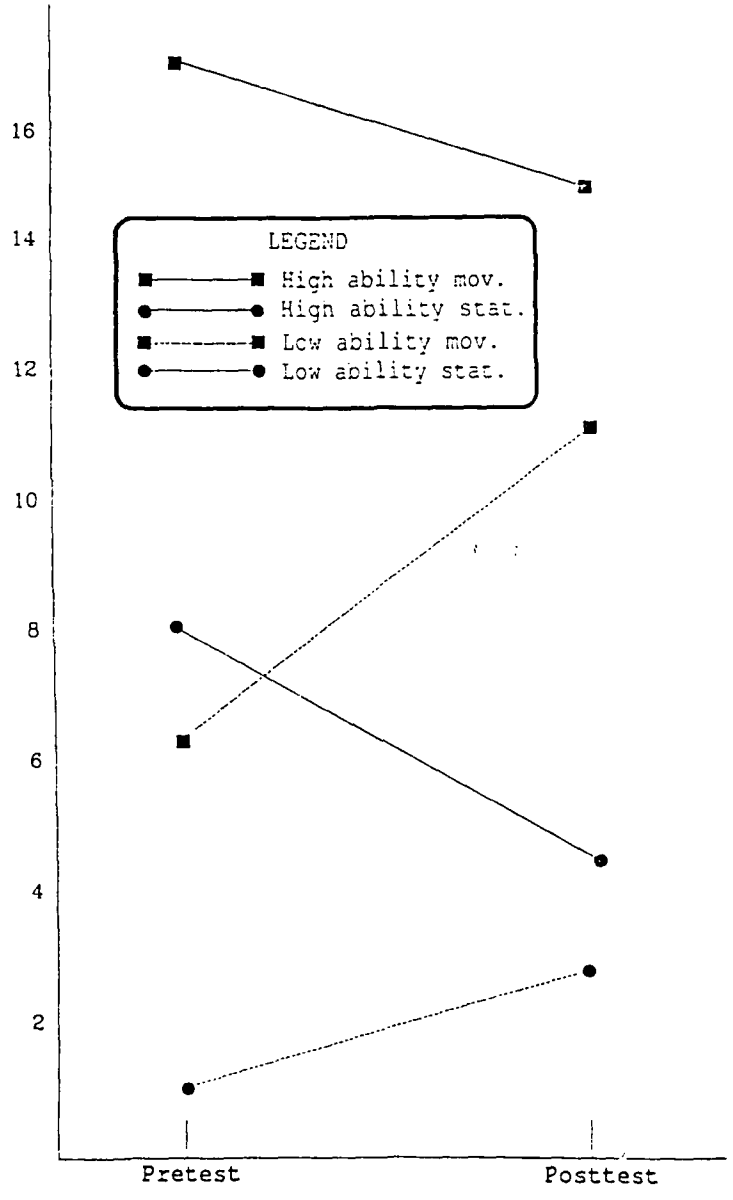

Figure 6. Pretest and posttest performance for stationary and moving targets hit for the high and low ability groups in the one-day training program.

training on the MACS and Weaponeer II on Day 1 which was identical to that described for the experimental group in the one-day training program. On Day 2 the control group received the current ARM POI for engaging moving targets which was identical to that described for the control group in the one-day training program. Prior to the commencement of training on Day 2, the experimental group was separated from its company and received device training on the LOMAH system. The same program of instruction was used as for the one-day program of training. On completion of device training, the experimental group rejoined their company during the firing of the 42-target/42-round scenario at the DTR. The second firing of the 42-target/42-round scenario for soldiers in the control and experimental groups served as the posttest for this experiment. The procedure of assigning soldiers in each group to firing positions was identical to that described for the one-day training program.

Results

A 2 (Group) x 2 (Stationary Targets, Moving Targets) x 2 (Pretest, Posttest) ANOVA with repeated measures on the second and third factors was conducted to compare the marksmanship performance of soldiers in the two treatment groups. A Bartlett's test for homogeneity of variance indicated that the control and experimental groups were comparable in their marksmanship ability prior to moving target engagement training, $X2$ (1, N = 56) = .49, $p > .05$.

The Group x Targets x Pretest/Posttest interaction was not significant, $F(1,54) = 2.55$, $p > .05$. This finding indicated no inter or intragroup differences between the two treatment groups for stationary and moving targets hit for the pretest or the posttest. While the comparison between the two groups was not statistically significant, the means were consistently in the expected direction.

A summary of the performance of soldiers in the control and experimental groups on the pretest and posttest is presented in Table 3. The standard deviations were consistently lower on the posttest than on the pretest for the experimental group. These results paralleled those obtained in Experiment 1.

As in Experiment 1, an additional analysis was conducted based on initial ability. Soldiers were assigned to one of four groups based on individual pretest total scores on the DTR: (1) low ability control (n = 7); (2) high ability control (n = 7); (3) low ability experimental (n = 7); and (4) high ability experimental (n = 7). A 2 (Group) x 2 (Initial Ability) x 2 (Stationary Targets, Moving Targets) x 2 (Pretest, Posttest) ANOVA with repeated measures on the third and fourth factors was used in this analysis.

The Group x Ability x Targets x Pretest/Posttest interaction was marginally significant, $F(1,24) = 3.87$, $p < .06$. This interaction showed that high ability shooters in the control and experimental groups performed at a comparable level during the pretest and posttest (see Table 4). However, the low ability shooters demonstrated a considerable improvement between the pretest and posttest for stationary and moving targets hit for both the control and experimental groups (see Figure 7).

Table 3

A Summary of the Number of Hits Obtained by Each Group in the Two-Day Training Program

Type of Target		Group: Experimental (n = 28)	Group: Control (n = 28)
Moving			
pretest	M	12.18	11.74
	SD	5.03	4.97
posttest	M	15.50	12.89
	SD	4.01	4.47
Stationary			
pretest	M	5.89	5.41
	SD	2.25	2.61
posttest	M	6.39	5.89
	SD	1.97	2.36
Total			
pretest	M	18.07	17.14
	SD	6.37	6.23
posttest	M	21.89	18.78
	SD	5.27	5.76

Table 4

A Summary of the Number of Hits Obtained by Each Group in the Two-Day Training Program Based on Initial Marksmanship Ability

Type of Target		Condition			
		Experimental Group		Control Group	
		Low-Ability Shooters (n = 7)	High-Ability Shooters (n = 7)	Low-Ability Shooters (n = 7)	High-Ability Shooters (n = 7)
Moving					
pretest	M	5.43	18.14	7.42	16.43
	SD	2.63	2.48	3.74	3.05
posttest	M	13.71	15.71	11.00	14.57
	SD	3.86	5.94	3.16	5.13
Stationary					
pretest	M	4.43	7.71	2.14	7.85
	SD	1.99	2.36	1.46	1.57
posttest	M	6.43	6.29	5.00	6.07
	D	2.51	1.80	2.58	3.53
Total					
pretest	M	9.86	25.85	9.56	24.28
	SD	3.89	2.79	4.12	3.59
posttest	M	20.14	21.89	16.00	20.64
	SD	5.18	7.44	5.23	7.83

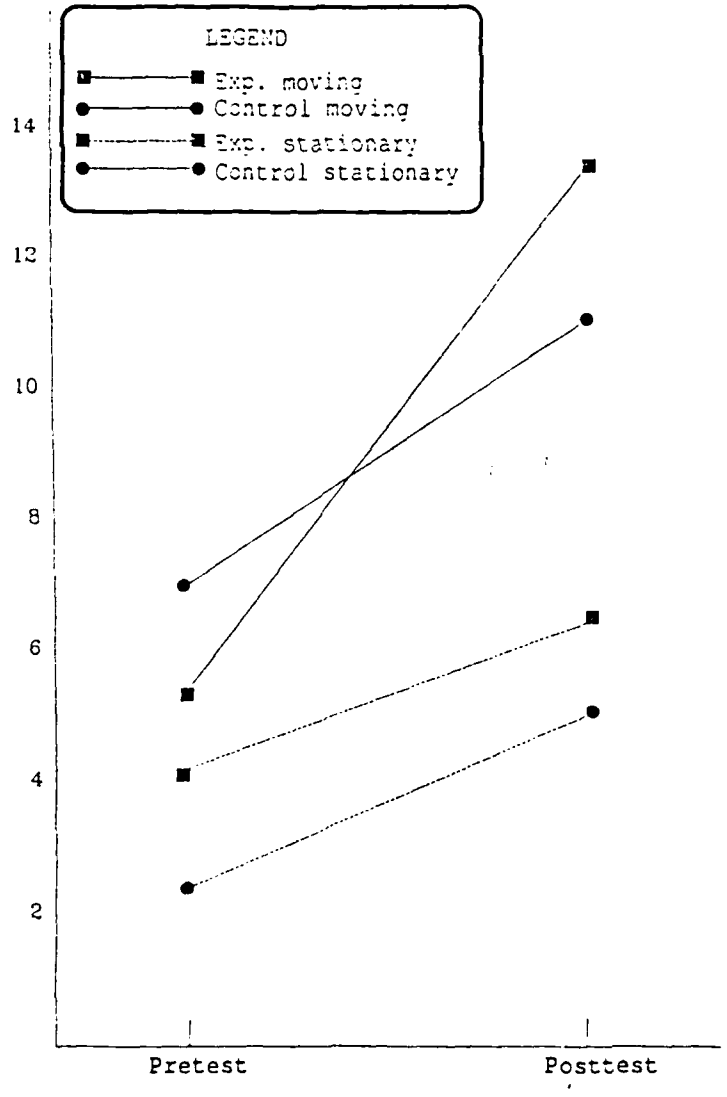

Figure 7. Pretest and posttest performance for stationary and moving targets hit for the low ability groups in the two-day training program.

The low ability shooters in the control group showed an overall improvement of 67% from the pretest to the posttest, whereas the low ability shooters in the experimental group showed an overall improvement of 104% from the pretest to the posttest. The locus of this effect for both treatment groups could largely be attributed to the increased number of moving targets hit during the posttest (see Table 4). While this finding is only marginally significant statistically, it represents a significant improvement from a pragmatic perspective.

Discussion

As with the one day training program, the findings for the two day training program were not statistically significant even though the trend of the means were in the expected direction.

The results of the analysis based on initial ability paralleled those obtained for the one-day training program indicating that soldiers in the low ability groups benefited significantly more from the training program than soldiers in the high ability groups. However, results for the two-day training program indicated significant performance differences between soldiers in the two treatment conditions. These results indicated that soldiers in the low ability experimental group showed an improvement of 37% over their control group counterparts.

The results obtained for the low ability soldiers in the experimental group were again achieved with minimal soldier/device interaction, the only difference was that the instruction on the devices was spread over a two day period in an attempt to minimize the risk of information overload. The results appear to support this notion. Overall, the results for this experiment indicated that device-based training can be effective in improving subsequent live-fire performance, and this was achieved with minimal soldier/device contact and without performance standards for the special devices. The next experiment ensured that performance standards on each device were met prior to live-fire exposure. This was accomplished by training soldiers to achieve a performance standard three consecutive times on each device used in the one and two-day training programs.

EXPERIMENT 3: TRAINING TO STANDARD THREE CONSECUTIVE TIMES IN A ONE-DAY TRAINING PROGRAM

The purpose of this experiment was to examine the effect of training soldiers to achieve a performance standard three consecutive times on live- fire performance. This program used the same devices described for the one and two-day training programs. Soldiers in this experiment were required to perform to standards three consecutive times on each device.

Method

Subjects

Subjects were 14 Infantry OSUT soldiers undergoing ARM training at Fort Benning, Georgia. Soldiers were assigned either to a control group (n = 7) or an experimental group (n = 7). Selection of subjects was identical to that described for Experiment 1.

Equipment and Measures

The same equipment and measures were used as for the one-day training program.

Procedure

The control and experimental groups fired a 42-target/42-round attack/retreat scenario on the DTR as a pretest. After the pretest the control group (n = 7) rejoined their company. The experimental group (n = 7) received the same device-based training outlined in Experiment 1 with the exception that soldiers were required to meet or exceed predetermined standards on each device three consecutive times. The MACS system standard was six hits out of a possible nine moving target exposures (67%) in the moving target scenario. The Weaponeer II standard was 25 targets hit out of a possible 40 (10 stationary, 30 moving) target exposures in the record fire scenario (62%). Soldiers were randomly recycled between the MACS and Weaponeer II devices until the standards were met or exceeded. The LOMAH standard was 10 targets hit out of a possible 15 moving target exposures (67%). On completion of device training, the experimental group rejoined their company during the firing of the 42-target/42-round scenario at the DTR. The procedure of assigning soldiers in each group to firing positions for the posttest was identical to that described for Experiment 1.

Results

A 2 (Group) x 2 (Stationary Targets, Moving Targets) x 2 (Pretest, Posttest) ANOVA with repeated measures on the second and third factors was conducted to compare marksmanship ability between the two treatment groups. A Bartlett's test for homogeneity of variance showed no difference between the marksmanship ability of the two treatment groups prior to moving target engagement training, $X2$ (1, N = 14) = .27, $p > .05$.

The Group x Targets x Pretest/Posttest interaction was not significant, $F(1,12) = .13$, $p > .05$, although the trend of the means were in the expected direction and paralleled those obtained in the previous experiments. A summary of the performance of soldiers in the control and experimental groups on the pretest and posttest is presented in Table 5.

Discussion

The results for the control group for this experiment replicated those obtained for Experiment 1. These findings were consistent with the earlier suggestion that learning in this type of training schedule may be limited by an information overload associated with the intensity of the program. In addition, this particular program used a massed practice training schedule, which is not necessarily the optimum learning environment for marksmanship. These results do

Table 5

A Summary of the Number of Hits Obtained by Each Group in the One-Day Training Program: Training to Standard Three Consecutive Times

Type of Target		Group: Experimental (n = 7)	Group: Control (n = 7)
Moving			
pretest	M	12.71	12.00
	SD	5.31	3.61
posttest	M	14.86	13.57
	SD	5.34	5.03
Stationary			
pretest	M	4.57	5.43
	SD	3.05	3.10
posttest	M	6.00	5.43
	SD	1.29	2.23
Total			
pretest	M	17.29	17.43
	SD	7.09	5.25
posttest	M	20.86	19.00
	SD	4.78	7.00

not mean that training to standard with repetition is an inappropriate training concept; however, in order to provide an environment conducive to maximize learning a more distributed practice schedule probably should be adopted. It is likely that such a program would require an additional day of training similar to the two-day training program described in Experiment 2.

A question common to moving target engagement is that of tracking versus trapping a target. Up to this point, soldiers were taught to track moving targets. The next experiment was conducted to determine if there was any additional benefit associated with trapping moving targets.

EXPERIMENT 4: A COMPARISON BETWEEN TWO METHODS OF ENGAGING MOVING TARGETS

The purpose of this experiment was to determine the relative effectiveness of two methods of engaging moving targets: tracking and trapping. Tracking involves maintaining the muzzle of the weapon at a selected aiming point leading the target in the direction of travel and firing when the target is properly aligned with the sights. Trapping involves holding the muzzle ahead of the target in its expected direction of travel and firing when the target passes through the aiming point (Schendel & Johnston, 1983). In the previous experiments, soldiers in the experimental groups were taught to track targets exclusively. Soldiers in this experiment were taught both methods of engaging moving targets using devices and then tested on the DTR.

Method

Subjects

Subjects were 14 Infantry OSUT soldiers randomly selected from a company undergoing ARM training at Fort Benning, Georgia.

Equipment and Measures

The same procedures and measures were used as for Experiment 1.

Procedure

Soldiers were assigned to two groups, one group (n = 7) received tracking on Day 1 and trapping on Day 2, the other group (n = 7) received trapping on Day 1 and tracking on Day 2. The soldiers fired the same 42-target/42-round attack/retreat scenario described in Experiment 1 as a pretest. The same device-based training outlined in Experiment 1 was used for this experiment except for the additional requirement of training soldiers to track and trap targets.

Results

A counterbalanced within subjects design was used for this experiment. Dependent, two-tailed *t*-tests were used for within group performance comparisons. A separate *t*-test was conducted for each of the following dependent measures: tracking and trapping posttest total hits, and tracking and trapping posttest moving targets hit. The difference between the mean number of total targets hit for tracking (M = 21.62) and trapping (M = 21.0) was not statistically significant, $t(12) = .66$, $p > .05$. Similarly, the difference between the mean number of moving targets hit was not significant, $t(12) = 1.14$, $p > .05$. A summary of the performance for tracking and trapping is presented in Table 6.

Table 6

A Summary of the Number of Posttest Hits Obtained in Two Methods of Moving Target Engagement: Tracking and Trapping

		Method	
Type of Target		Tracking	Trapping
Moving	*M*	15.15	14.08
	SD	4.47	4.37
Stationary	*M*	6.47	6.92
	SD	1.90	1.75
Total	*M*	21.62	21.00
	SD	4.39	4.02

Note. n = 14

Discussion

The results suggest that both tracking and trapping represent viable methods of engaging moving targets. Perhaps, soldiers should be taught both methods of engagement so they could choose the most appropriate method of engagement for a given target. Schendel and Johnston (1983) showed that trapping was superior for low ability shooters and for distant targets moving at slow speeds. Tracking was better for high ability shooters and for close targets moving at faster speeds. A comparable analysis was not performed on the

present experiment. This would require further study to answer this question. An informal post-experimental interview with soldiers participating in this experiment indicated that they preferred to be taught both methods of target engagement. Recent research investigating these two methods of engaging moving targets concluded that soldiers should be taught both tracking and trapping (Schendel & Johnston, 1983).

An additional question regarding engaging moving targets is the effectiveness of semiautomatic fire compared with burst fire. The five experiments described so far taught soldiers to engage each target with one round of ammunition. This method of instruction emphasized the fundamentals of marksmanship and the importance of a single well-aimed shot. The next experiment examined the relative effectiveness of semiautomatic fire and three-round burst fire in moving target engagement.

EXPERIMENT 5: SEMIAUTOMATIC VERSUS THREE-ROUND BURST FIRE: A COMPARISON BETWEEN TWO METHODS OF ENGAGING MOVING TARGETS

The purpose of this experiment was to investigate the effect of multiple round target engagement using three-round burst fire versus single round target engagement using semiautomatic fire. Soldiers in this experiment were instructed in both modes of fire and tested at the DTR.

Method

Subjects

Subjects were six Infantry OSUT soldiers undergoing ARM training at Fort Benning, Georgia.

Equipment and Measures

The same equipment and measures were used as described for Experiment 1. The exceptions were that semiautomatic fire was conducted with each soldier's M16A1 rifle with M193 5.56 mm ball ammunition and burst fire was performed with an issued M16A2 rifle using M885 5.56 mm ball ammunition, a lower velocity but heavier round than the M193 5.56 mm.

Procedure

Three subjects fired semiautomatic followed by burst fire, and three subjects fired burst fire followed by semiautomatic fire. No live-fire pretest was given in this experiment due to time limitations. Both groups received the same device-based training described in Experiment 1, with the following constraints: (1) It was not possible to instruct burst fire on the MACS and Weaponeer II devices; and (2) burst fire was limited to device training on the LOMAH system. Upon completion of the device training, both groups fired two

iterations of a 42-target/42-round attack/retreat scenario on the DTR as a posttest. Each soldier fired both semiautomatic and burst fire during the posttest.

Results

A counterbalanced within subjects design was used for this experiment. A series of dependent, two-tailed *t*-tests was conducted to compare posttest performance between semiautomatic and burst fire. A separate *t*-test was conducted for each of the following three dependent measures: posttest total targets hit, posttest moving targets hit, and posttest stationary targets hit.

The difference between total targets hit using burst fire (M = 20.83) and semiautomatic fire (M = 19.50) was not significant, $t(5) = -.93$, $p > .05$. Similarly, the results for moving targets, $t(5) = -1.90$, $p = .12$, and station ary targets, $t(5) = 1.04$, $p > .05$, indicated no significant differences between semiautomatic and burst fire. The results for burst fire and semiautomatic fire are summarized in Table 7.

Table 7

A Summary of the Number of Posttest Hits Obtained in Two Firing Conditions: Semiautomatic versus Three Round Burst

		Condition	
Type of Target		Semiautomatic	Burst
Moving	*M*	14.17	16.50
	SD	2.64	4.37
Stationary	*M*	5.33	4.33
	SD	3.62	3.83
Total	*M*	19.50	20.83
	SD	4.68	7.14

Note. n = 6

Discussion

The results from this experiment indicated that burst fire was not superior to semiautomatic fire for engaging moving targets. A possible explanation for these results is that the performance of a skill that requires a high degree of motor control, in this case engaging a stationary or moving target, can be disrupted by the use of burst fire. The reason for this is that after firing the first shot in burst mode, the soldier is less likely to have full control of the weapon to successfully reengage the target. In addition, the results from this experiment suggested that the availability of additional ammunition had a minimal effect on a soldier's ability to hit significantly more targets. The following experiment investigated this question further.

EXPERIMENT 6: EFFECTS OF ADDITIONAL AMMUNITION ON TARGETS HIT IN A ONE-DAY TRAINING PROGRAM

The purpose of this experiment was to examine the effect of additional ammunition availability on targets hit. All previous experiments, with the exception of Experiment 5, have emphasized the need for one carefully aimed shot at each target exposure. In this experiment, soldiers were instructed to fire one carefully aimed shot when firing the 42-target/42-round scenario, and they were free to engage any target they missed with more than one round when firing the 42-target/63-round scenario.

Method

Subjects

Subjects were 56 Infantry OSUT soldiers undergoing ARM training at Fort Benning, Georgia. Soldiers were selected from a company receiving the current ARM POI for engaging moving targets.

Equipment and Measures

As described for the control group in Experiment 1.

Procedure

Half (n = 28) of the soldiers fired the 42-target attack/retreat scenario with 42-rounds of ammunition and then fired the same scenario with 63-rounds of ammunition. The remaining soldiers fired the same scenario using 63-rounds of ammunition followed by 42-rounds of ammunition. The same 42-target/42-round attack/retreat scenario described in Experiment 1 was used in this experiment. All soldiers received the current ARM POI training for engaging moving targets detailed in Experiment 1. On completion of training, soldiers were assigned to a specific firing order and firing position which was constant for both firings of the test scenario.

Results

A counterbalanced within subjects design was used for this experiment. A 2 (Stationary Targets, Moving Targets) x 2 (Number of Rounds) ANOVA was used for this experiment. The Target x Number of Rounds interaction was not significant, F (1,27) = 3.50, p > .05. These results are summarized in Table 8.

Discussion

The additional ammunition did not lead to an increase in the number of targets hit for the subjects used in this experiment. The failure, in this case, of 50% more ammunition to significantly increase the number of targets hit on the same scenario has to be considered in terms of cost effectiveness. These results showed that for an increased cost of 50% there was a 0% increase in performance. In addition, the hit probability for all targets was almost identical when 63 rounds (p = .47) and 42 rounds (p = .42) of ammunition were used.

All experiments described to this point have been device-based programs or they have used counterbalanced within-subject designs to investigate a specific question. In order to determine if there were alternative training methods that were comparable to the two-day training program described in Experiment 2, an additional live-fire program was developed which used an intermediate live-fire training scenario.

Table 8

A Summary of the Number of Posttest Hits Obtained by Two Groups With Diverse Amounts of Ammunition Availability

		Group	
Type of Target		42-target/42-round	42-target/63-round
Moving	M	11.82	12.82
	SD	3.91	4.05
Stationary	M	5.41	5.86
	SD	2.40	2.55
Total	M	17.23	18.68
	SD	5.38	5.81

Note. n = 56

EXPERIMENT 7: EVALUATION OF AN INTERMEDIATE LIVE-FIRE TRAINING SCENARIO IN A ONE-DAY TRAINING PROGRAM

All previous experiments examined the effects of different modes of fire, additional ammunition, and different amounts of device-based training on moving target engagement. The purpose of this experiment was to determine the effectiveness of an intermediate live-fire training scenario on moving target engagement training in a one-day training program.

Method

Subjects

Subjects were 145 Infantry OSUT soldiers undergoing ARM training at Fort Benning, Georgia. Soldiers were assigned either to a control group (n = 61), experimental group 1 (n = 42) or experimental group 2 (n = 42). The soldiers used in this experiment consisted of an entire company scheduled to receive the current ARM POI for moving target engagement. Selection procedures for soldiers in the experimental groups were identical to those described for Experiment 1.

Equipment and Measures

Only the DTR was used for this experiment. The 42-target/42-round attack/retreat scenario used in this experiment was identical to that used in all previous experiments and it was detailed in Experiment 1. In addition, an intermediate live-fire training scenario was developed for this experiment. The intermediate training scenario was a 39-target/39-round scenario which progressed in two stages. Soldiers firing the intermediate training scenario were issued two magazines, one with 19 rounds, the other with 20 rounds.

Stage I (0-99 s) consisted of random presentation of six single exposures of stationary E and F-type silhouette targets at ranges of 50 to 300 m. This was followed by the random presentation of ten moving (E-type) target exposures at ranges of 15 to 185 m. Target speeds were the same as those detailed for the 42-target/42-round attack/retreat scenario in Experiment 1. The purpose of this stage of the scenario was to make the soldiers aware of the possible target locations in which a threat might occur.

Stage II (111-263 s) consisted of 23 target exposures in an attack/retreat scenario and was comprised of seven stationary E and F-type target exposures and 16 (E-type) moving target exposures. Because this scenario was designed as an instructional intermediate training scenario, a manual pause option was programmed between Stages I and II for instructional purposes. A 60 second pause was used during this experiment. Target engagement in each phase commenced when the first target appeared and continued without interruption. The scenario required the soldier to execute a rapid magazine change and to correct any rifle malfunctions. Sufficient time (5 seconds) was programmed between target exposures 18 - 21 to allow the soldier to make a magazine change without missing a target exposure (a frequent occurrence during the previous

experiments was that soldiers often missed up to 4 target exposures while making a magazine change). At the completion of the scenario, a summary sheet of the hits at each target range and the total number of hits was printed for each firing position.

Procedure

A live-fire pretest was not administered to either the control group or the experimental groups due to resource constraints. All groups received the current ARM POI for engaging moving targets described in Experiment 1. Subjects in the control group (n = 61) then fired the 42-target/42-round scenario as a posttest. Subjects in experimental group 1 (n = 42) fired the 42-target/42-round scenario as practice prior to firing the 42-target/42-round scenario as a posttest. Subjects in experimental group 2 (n = 42) fired the 39-target/39-round intermediate training scenario prior to firing the 42-target/42-round scenario as a posttest. Soldiers in both experimental groups were assigned to a specific firing point prior to live-fire. The same firing point was used for both iterations of live-fire. Data for the 42-target/42-round practice scenario and the 39-target/39-round intermediate training scenario were collected along with the posttest data for the control and experimental groups.

Results

A 3 (Group) x 2 (Staticnary Targets, Moving Targets) ANOVA with repeated measures on the second factor was conducted to compare the marksmanship performance of soldiers in the three treatment groups. The main effect for moving targets, $F(2,144) = 8.92$, $p < .001$, was significant. A Tukey post hoc analysis revealed that the control group (M = 10.6) hit significantly fewer moving targets than experimental groups 1 (M = 13.0) and 2 (M = 13.9). The difference between the experimental groups was not significant. Similarly, the main effect for stationary targets, $F(2,144) = 1.62$, $p > .05$, was not significant. The means for targets hit for each treatment group are summarized in Table 9.

Discussion

The findings from this experiment showed that the utilization of an intermediate live-fire exercise resulted in an increased number of moving targets hit. The performance of the two experimental groups was comparable for both moving and stationary targets. The inclusion of the experimental group who fired the same 42-target/42-round scenario for practice prior to the posttest was to determine if successive exposure to the same scenario facilitated performance. The comparison between this group and the control group was significant and the hypothesis was supported.

The final experiment in this research effort used a combination of device-based training described in Experiment 1 and the use of an intermediate training scenario described in Experiment 8. In addition, all training in the final experiment was conducted by Company Cadre trained by the research staff.

Table 9

A Summary of the Number of Posttest Hits Obtained by Each Group in the Intermediate Training Scenario in a One-Day Training Program

Type of Target		Group		
		Experimental 1 (n = 42)	Experimental 2 (n = 42)	Control (n = 61)
Moving	M	13.00	13.91	10.59
	SD	3.74	4.59	3.98
Stationary	M	6.55	6.50	5.75
	D	2.54	2.23	2.74
Total	M	19.55	20.41	16.39
	SD	5.33	5.38	5.26

EXPERIMENT 8: EVALUATION OF A TWO-DAY TRAINING PROGRAM CONDUCTED BY COMPANY CADRE

This experiment was performed to investigate the effectiveness of a two-day training program conducted by company cadre on moving target engagement. This program of instruction used a combination of training methods implemented in the previous experiments. One experimental group received device-based training and an intermediate live-fire exercise, while another experimental group received a modified moving target engagement training program in conjunction with an intermediate live-fire exercise.

Method

Subjects

Subjects were 162 Infantry OSUT soldiers undergoing ARM training at Fort Benning, Georgia. Soldiers were either assigned to a control group (n = 84), experimental group 1 (n = 40) or experimental group 2 (n = 38) (see Footnote 4). Selection of soldiers for the experimental groups was identical to that described for Experiment 1.

Equipment and Measures

As described for Experiment 1.

Procedure

Six Drill Sergeant qualified Noncommissioned Officers (NCOs), randomly selected from a pool of 11 company cadre, were trained by the research staff to instruct experimental group 1 (n = 40). Training of the NCOs was limited to one day due to time constraints. Soldiers in experimental group 1 received identical device-based instruction to that described in Experiment 2, in addition they fired the 39-target/39-round intermediate training exercise described in Experiment 8 prior to the posttest. The control group (n = 84) received the current ARM POI for engaging moving targets (see Experiment 1).

Soldiers in experimental group 2 were trained by a NCO assigned to the DTR instructional staff (see Footnote 5). Training for this group was identical to that described for the control group with two exceptions: (a) the AIM book was used to instruct the single lead rule for engaging moving targets rather than five lead rules; (b) this group confirmed their zero on a 25-meter range prior to firing the 39-target/39-round intermediate training exercise and the posttest. NCOs performed all principal and assistant instructor duties for soldiers in the experimental groups. Pretests were not administered due to resource constraints. The same 42-target/42-round attack/retreat scenario described for the one-day training program was used in this experiment.

Results

A 3 (Group) x 2 (Stationary Targets, Moving Targets) ANOVA with repeated measures on the second factor was conducted to compare the marksmanship performance of soldiers in the three treatment groups. The main effect of stationary targets hit, $F(2,163) = 4.02$, $p < .05$, was significant. A Tukey post hoc test showed that experimental group 1 (M = 7.05) had significantly more stationary targets hit than the control group (M = 5.47). The difference between the experimental groups was not significant. Similarly, the main effect for moving targets hit, $F(2,163) = 5.45$, $p < .01$, was also significant. The post hoc test showed that experimental group 1 (M = 13.48) hit significantly more moving targets than the control group (M = 10.45). The difference between the experimental groups was not significant. The means for targets hit for each treatment group are summarized in Table 10.

Discussion

This experiment was the first in which a platoon was tested using the device-based training outlined in the one-day training program. In addition, NCOs were used as instructors instead of the research staff. The results clearly indicated that device-based training was superior to the current ARM POI. These results were more impressive than results for previous experiments when one considers that instructor training for the NCOs in this experiment was

limited to one day due to resource constraints. While the differences between the experimental groups was not significant, the trend of the means were in the expected direction.

GENERAL DISCUSSION

The purpose of this research effort was to develop a training program that would result in a significant improvement in a soldier's ability to engage moving targets. The main thrust of this research used both the incorporation of device-based and modified live-fire training to attain this goal.

The most significant findings in this research effort were obtained in the two-day training program with initial marksmanship ability used as a between subjects factor. These data indicated that device-based training was extremely beneficial to low-ability shooters identified on the basis of their pretest scores. While performance for high-ability shooters was similar between the pretest and posttest, performance on the posttest for the low-ability shooters improved by approximately 104% over their pretest performance. A possible explanation for the dramatic performance improvement for soldiers in the low ability group may be attributable to their exposure to a knowledge-rich environment in which precise feedback was available as they performed the specific marksmanship tasks on each of the devices.

A fundamental requirement in teaching a skill is the use of feedback in identifying to the performer what was right or wrong with the execution of the skill. The benefit of device-based training was its immediate feedback capability. This ability was consistent for all systems used during this research effort. This capability allowed the instructor to analyze the soldiers' performance in fine detail and identify any breakdown in the skill which caused a detriment in performance. The utility of providing precise feedback was that it allowed analysis of the skill in a controlled environment where solutions to particular problems could be implemented in the absence of conjecture on the part of the instructor. In contrast, any instructional feedback given in a live-fire situation with a series of timed target exposures (with the exception of LOMAH) has, by necessity, to be delayed until after the completion of the scenario. In addition, the precision of the feedback may be adversely affected by the uncontrollable extraneous variables inherent in an applied setting. While a delay of feedback may not affect the skilled performer, it is doubtful that this is an optimum method of teaching less-skilled performers (Salmoni, Schmidt & Walter, 1984).

One method of training that was not beneficial in terms of posttest scores was requiring soldiers to perform to standard three times in succession on each device. Training to standard was conducted in a 4-hour period and was extremely fatiguing for the soldier. The fatigue factor was very similar to that identified in the one-day program. The learning benefit attributed to this type of training may be confined to the device itself and lead to no greater transfer to live-fire than one iteration on each device. Distributed practice over a two-day program may provide more definitive results for this training method. An alternative, which was not tested, would be to require soldiers to perform to standard on each device using different scenarios. The assumption being that

successful performance on every scenario requires appropriate application of the fundamentals required to engage moving targets. This method of training would, however, be equally costly in terms of personnel time.

Overall, the results from this research effort demonstrated that soldiers could be taught to hit more moving targets. The increase in hits for posttest scores was accounted for by the increase in moving targets hit from the pretest to the posttest. The benefit of both device-based training using special devices and the incorporation of an intermediate live-fire training scenario provided valuable information for the development of a cost-effective POI. At present it is anticipated that this POI could utilize device-based training and modified live-fire training over a two-day training period.

Summary

The most significant findings obtained during this research effort were for soldiers in the low ability experimental group in the two-day training program, the intermediate live-fire scenario in a one-day training program, and the company training in a two-day training program by company cadre. The results of these three experiments consistently demonstrated the superior posttest performance of the experimental groups over the control groups. The comparisons between pretest and posttest performance for experimental groups indicated an average increase of four hits for each soldier. This finding was largely attributable to the increase in the number of moving targets hit.

The significance of these findings is especially pertinent when the comparisons between the low-ability and high-ability shooters from Experi ments 1 and 2 are considered. These findings indicated that low-ability shooters showed a 99% performance improvement on the posttest over their pretest score for total targets hit. In addition, the improvements for moving targets hit (100.1%) and stationary targets hit (96.7%) were consistently high. In comparison, the low-ability shooters for the control group showed improvements of 53.8%, 52.6%, and 56.4% for total targets hit, moving targets hit, and stationary targets hit respectively.

Overall, these results provide evidence that moving target engagement can be improved with a combination of device training and a modified POI utilizing an intermediate live-fire exercise. At present, the utility of one program over another has not been determined and awaits further evaluation.

Table 10

A Summary of the Number of Hits Obtained by Each Group in the Two-Day Training Program Conducted by Company Cadre

Type of Target		Group		
		Experimental 1 (n = 40)	Experimental 2 (n = 38)	Control (n = 84)
Moving				
intermediate	M	11.88	10.18	-----
	SD	3.66	4.09	-----
posttest	M	13.48	12.13	10.45
	SD	4.43	3.71	4.37
Stationary				
intermediate	M	6.28	5.53	-----
	SD	2.80	2.46	-----
posttest	M	7.05	6.47	5.47
	SD	2.68	2.06	2.37
Total				
intermediate	M	18.03	15.71	-----
	SD	5.24	5.17	-----
posttest	M	20.53	18.61	15.95
	SD	6.11	4.58	5.71

FOOTNOTES

Note 1. The speed of the targets was based on the reported speed of targets (1.8, 2.7, and 3.7 m/s) at the DTR (Department of the Army, 1985). The actual speeds of the targets were converted to apparent lateral speed because the RETS targets at the DTR move at an angle of 45 degrees to the firing line. This transformation resulted in apparent lateral speeds of 2.8, 4.8, and 5.7 mph.

Note 2. Training with special devices was conducted with three Multipurpose Arcade Combat Simulator (MACS) systems, two Weaponeer II systems, and one Superdart Location of Miss and Hit (LOMAH) system. In many cases these resource constraints did not allow the testing of large sample sizes. The preferred sequence of training with the special devices was: 1. MACS; 2. Weaponeer II and; 3. LOMAH. This allowed progression from the part-task computer simulation of marksmanship skills on the MACS using a recoilless dummy M16 rifle to the full-task Weaponeer II simulator which uses a non-restorable M16 rifle with recoil and sound capabilities to live-fire on the LOMAH system.

Note 3. A group cell mean was included as data in the ANOVA for one soldier in the control group analysis because he was unable to fire the posttest.

Note 4. Data from two soldiers in Experimental Group Two were dropped from the analysis because they were unable to complete the course of training for this experiment. This reduced the size of this group from 40 to 38.

Note 5. Instruction of concurrent training stations for all soldiers in the control groups during this research effort was conducted by a single NCO at each training station. It was the purpose of this experiment to keep the instructor/soldier ratio of 1:40 (approximately). Thus, the only modification of the POI for experimental group two was that the soldiers received instruction on the single lead rule instead of five lead rules and that they confirmed their zero prior to firing the intermediate live-fire exercise and the posttest.

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